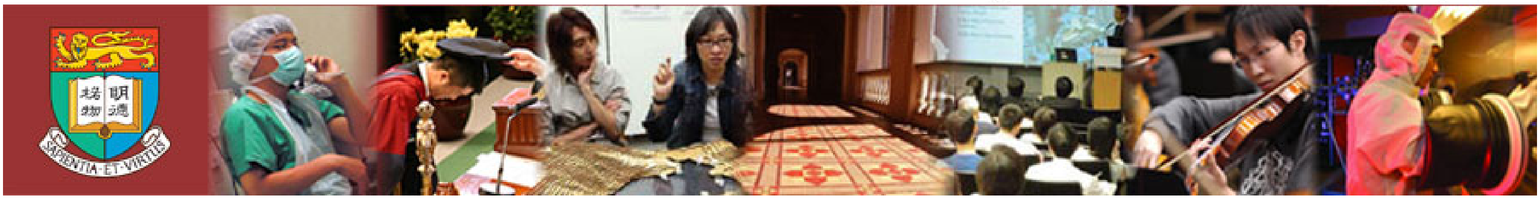

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Interaction between homophony and semantic transparency of Chinese characters on dictation across primary grades

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Abstract

Ninety students from Grade One, Three and Five of normal primary schools were tested under a writing-to-dictation paradigm to investigate the interaction of semantic transparency and homophonic neighborhood size on children's lexical processing of low-frequency Chinese semantic-phonetic compound characters across grades. Significant semantic transparency effect indicated that nature of paradigm determines the employment of information carried by semantic radicals in lexical processing. Children of Grade One are able to master the skill of inferring semantic radical in writing. Significant 3-way interaction suggested that transparency effect was shown under high homophonic neighbourhood size condition in Grade five students. Extensive homophony in Chinese induces competition in both semantic and orthographic representations resulted in the adoption of sub-character semantic radical processing to retrieve exact meaning of target character. The disturbance of homophonic neighbourhood size in dictation becomes prominent as children move up the grades.

Introduction

Chinese property: extensive homophony

Existence of pervasive homophony is a property of Chinese language (Tan & Perfetti, 1997; Shu & Anderson, 1997). Homophones are words which sound the same but heteropgrahic. Thus, orthographically different characters may have the same pronunciations. For example, the syllable [jiu2] maps to three characters with different orthographies and semantics “繞” (around), “妖” (evil) and “擾” (disturb) as shown in figure a. These three characters are homophones. We define homophonic neighbourhood size as the number of homophones a character has as homophonic neighbourhood size. According to Li (2002), there are approximately 7,000 printed characters but with only 1,300 different spoken syllables in simplified Chinese characters. From the Hong Kong Corpus of Primary School Chinese which compiled of Chinese characters and words collected from primary school Chinese textbooks and workbooks (Leung & Lee, 2002), a primary six student has already learnt about 87.3% (3360 out of 3851) tradition Chinese characters which are having shared syllables.

Under the condition of extensive homophony, a phonological unit maps to many various orthographic and semantic units. In the study of Shu & Cheung (2001), homophonic errors accounts for the highest proportion under a writing-to-dictation task in sixth-grade made mistakes. It indicated that homophony has an essential impact on Chinese writing. A character with higher homophonic neighbourhood size (more homophones) has more connections from phonological node to its corresponding orthographic and semantic nodes (please refer to figure a). Tan & Perfetti (1997) proposed that the amount of activation from the phonological representation was fixed and character with higher neighbourhood size would activate each semantic and orthographic node less. Under the same principle, individual would perform better in characters with low homophonic neighbourhood size than character with high homophonic neighbourhood size in writing-to-dictation as a result of less inhibition among semantic and orthographic nodes connected to an auditory syllable. Nevertheless, the effect of homophonic neighbourhood size under a Chinese writing modality has not been investigated.

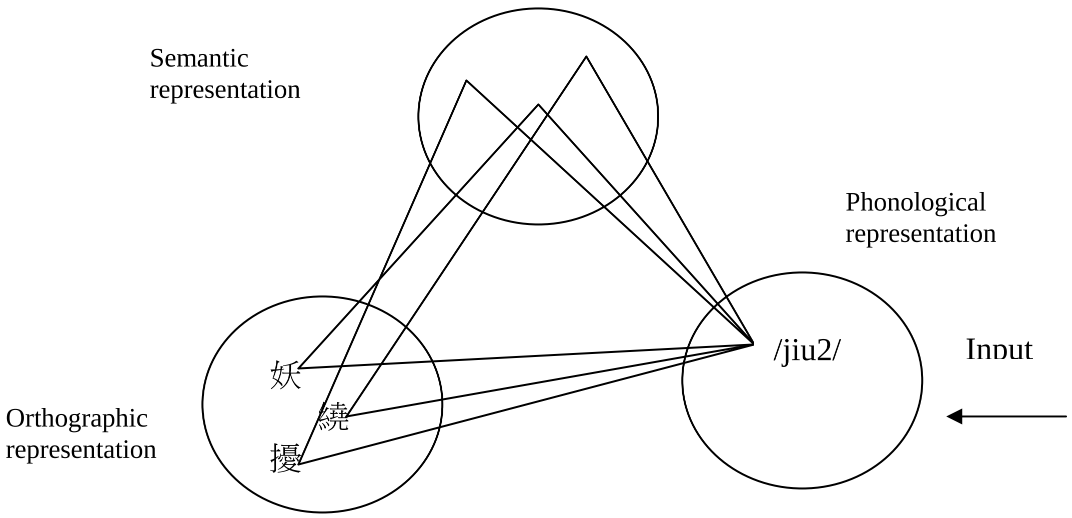

Figure a. A framework of the mental representation of orthographic, phonological and semantic information for a homophonic Chinese character

Children of higher grades acquire more vocabularies which in turn, will be influenced by more homophones. Actually, the homophonic neighbourhood size of characters expands across grades. For instance, syllable [*zuk1*] contains two homophonic members ‘足’ (leg) and ‘竹’ (bamboo) for a Grade One student as they have not yet learnt the other homophones of [zuk1]. On the contrary, the homophonic members increase to four ‘足’ (leg), ‘竹’ (bamboo), ‘祝’ (wish) and ‘捉’ (catch) for a Grade Three student as more characters has been learnt. It is hypothesized that the effect of homophonic neighbourhood size becomes more prominent as children promote to higher grade. Thus, it comes to two questions. First, whether there is homophony effect exists in a Chinese writing modality. Second, if there is homophony effect, any interaction with age.

Sub-character units in written Chinese

On top of the homophony issue, Chinese has been viewed as a logographic writing system, in which its characters map onto both meaning and sound. Over 80% of modern Chinese character population is semantic phonetic compounds (Chen, 1996). According to Chen (1996) and Hossain (1991) as cited in Shu & Anderson (1997), each compound character consists of two parts: the semantic radical which indicate the meaning category of the whole character and the phonetic radical which provides information to the pronunciation of the character. For example, in the character "捉" [zuk1] (*catch),* the phonetic radical, "足" [zuk1] provides a syllable cue to the pronunciation of that character whereas *"扌"(hand)* is the semantic radical which resembles a meaning of hand. In this case, the character "扌" is semantic transparent in which the semantic radical represents the same meaning category of the whole character "捉" *(catch)* -- use hand to catch (Flores d'Arcais, 1992 as cited in Shu & Anderson, 1997; Feldman & Siok, 1999). When the meaning of a semantic radical is inconsistent with the meaning of the whole character, the character is termed opaque. For example, the character **"**溫**"** [wun1] *(warm)***,** the semantic radical "氵" conveys the meaning of water which is unrelated to the meaning of the whole word. Analogously, a character with phonetic radical signals pronunciation identical to that of the whole characters is termed regular character. Meanwhile, a character with phonetic radical which pronunciation is not identical to the whole character is termed irregular character (Shu, Chen, Anderson, Wu & Xuan, 2003).

Role of phonetic radical in Chinese lexical processing

The unique characteristic of sub-characters which convey information of both sound and meaning has motivated researchers to investigate whether sub-character processing is involved in Chinese word reading. Most of recent studies evidenced that sub-character processing of phonetic radical existed in word recognition (Taft & Zhu, 1997), semantic judgment (Zhang, Perfetti & Yang, 1999) as well as word naming task (Lee, Tsai, Su, Tzeng & Hung, 2005; Yang & Peng, 1997 cited in Zhang et al., 1999; Chen, Anderson, Li & Shu, in press). Above findings suggested that Chinese readers were able to master a skill of extracting phonological information from the phonetic radical of a compound character in lexical processing. Applied more generally, sub-character processing of phonological radical plays an important role in Chinese lexical processing of reading modality in which orthographic representation is stimulated preliminarily.

Role of semantic radical in Chinese lexical processing

Contrary to the predominating sub-character phonetic radial processing, Zhou & Marslen-Wilson (1999) suggested that there is interactive accessing of orthography and phonology to semantics in Chinese Script due to the fact that the presence of semantic radicals in complex characters provides semantic category of the character. Although the semantic radical is one half of the constituents of a semantic-phonetic compound character, little attention was drawn among researchers. As mentioned above, transparent character provides semantic information of the whole character while opaque character does not. Better performance of transparent characters than opaque characters in Chinese reading and writing implicates that the employment of sub-character semantic radical processing of semantic radical exists.

A few studies have investigated the transparency effect in assessing character meaning in adult population (Feldman & Siok, 1999) and child population (Chung, 2004; Kwan, 2003; Ho, Wong & Chan, 1999; Shu & Anderson, 1997). Feldman & Siok (1999) reported that semantic radicals are used in lexical processing of characters as effects of semantic radial were shown in both character recognition and priming tasks. Concerning child readers, Ho et al., (1999) stated that children of grade one to three was able to use semantic analogy to cue the semantic meaning of complex characters which were newly learnt. Nevertheless, such conclusion was investigated after introducing the semantic analogy training. The results of Shu & Anderson (1997) revealed that there was significant transparency effect in third and fifth graders. The findings were questionable because of the research paradigm employed. A Pinyin replacement task is similar to a naming task that phonological information from the character was activated in the study of Shu & Anderson. In such case, the role of semantic radical awareness might not be revealed reliably (Kwan, 2003).

Insignificant transparency effect was found in both the studies of Chung (2004) and Kwan (2003) due to methodological fault. Semantic categorization task was used in which target characters were input in visual form in the two studies. Orthographic representation was stimulated in the initial stage which is identical to the form of input in reading aloud. (Under such circumstance, orthographic input representation is stimulated in tasks of semantic categorization which is identical to the initial stage of lexical processing in Chinese reading modality. Numerous studies evidenced that sub-character phonetic radical processing is crucial in Chinese reading modality (Chen, Anderson, Li & Shu, in press; Lee, Tsai, Su, Tzeng & Hung, 2005; Yang & Peng, 1997 as cited in Zhang et al., 1999). Inferring to phonetic radical for extracting information is preferable in semantic categorization task and resulted in insignificant transparency effect.

It is noteworthy that the investigation on the role of semantic radical to Chinese lexical processing is limited to character recognition, priming, semantic categorization and pinyin replacement tasks. These tasks are constrained by orthographical input as in the case of reading aloud so transparency effect might not be explicit.

Lexical processing in Chinese writing modality

Nevertheless, the sub-character processing of semantic radical in writing modality has not been investigated. Writing-to-dictation task is a feedbackward activity in which auditory information is the input whereas visual form is targeted as output. The orthographic output is constrained by phonology. When characters were input phonologically with an orthographic output, sub-character of phonetic radical processing failed to explain the whole picture of Chinese lexical processing given that the high proportion of homophony in Chinese language. Zhou & Marslen-Wilson (1999) argued that the relations between orthography and phonology are arbitrary as large number of homophony leads to the inconsistency between orthography and phonology. Extensive number of homophones induces a semantic competition between targeted character and the corresponding homophones (Zhou & Marslen-Wilson, 1999). Owing to the shared pronunciation, a spoken syllable activates the semantics as well as orthography of all its homophones. For example, the phonetic radical "足" of a character "捉" (catch) provides information the pronunciation of "zuk1" of the whole word, in turn activates its homophones which represent different semantic meanings, "粥" (congee), "祝" (wish) "築" (construction) "竹" (bamboo) and "足" (leg). Semantic retrieval is disturbed or delayed due to the semantic competition. Within this framework, making use of phonetic radical in processing characters is not reliable in a feedbackward activity of writing-to-dictation task. To overcome the extensive ambiguity because of pervasive homophones, context plays a large role in selecting a spoken word in sentence level (Li & Yip, 1996). Under the same principle, it is hypothesized that individual would infer semantic radical to cue the semantic meaning of a primed syllable in lexical processing to overcome semantic competition created. Exact retrieval of semantic representation can be employed which in turn maps to exact orthographic form. Thus, an interaction between semantic transparency and homophonic neighbourhood size in a writing-to-dictation paradigm is occurred. If it is the case, transparency effect would be explicit in writing-to-dictation paradigm under the condition of high homophonic neighbourhood size. Thus, it comes to other three questions. First, whether the sub-character semantic radical processing plays a role in writing. Second, if any interaction with homophonic neighbourhood size in writing.

Methodological consideration

In the present study, writing-to-dictation paradigm is adopted to examine the homophony and transparency effects in Chinese lexical processing. Writing-to-dictation paradigm is a superior method in investigating the effect of homophonic neighbourhood size and the role of semantic radical as well as their interaction in Chinese lexical processing. Dictation task that requires auditory information as input and visual form as output is targeted. Providing that large number of homophones, individual might need to infer semantic meaning carried by semantic radical to retrieve semantic meaning of phonological input.

In the current study, five factors: stroke number, syllable frequency, character frequency and word frequency and morphemic nature which represents either a single or plural meanings of a character under various context of word combination were controlled. According to the multilevel interactive-activation framework (Taft & Zhu, 1997), Chinese word processing involves the activation at stroke, radical, level, character and word levels. Since the semantic and phonological representations of high-frequency syllables, characters and words have stronger links within levels of one another, they would be activated directly quicker than their low-frequency counterparts. Hence, the control of syllabic, character and word frequency is needed. The results of a number of studies (Chung, 2004; Kwan 2003; Zhang et al., 1999) have evidenced that sub-lexical character processing occurs in low frequency characters but not in high frequency characters as individual may map a familiar character directly with meaning without decomposing radicals. Since we are interested in sub-character processing, low frequency characters were selected as stimuli for the present study.

Individual character can be combined with another character to form multi-character words in Chinese language. In multi-character words, character is classified as mono-morphemic in which it conveys identical meaning in different word combination whereas multi-morphemic character varies its meaning according to word combination (Shu et al., 2003). Transparency rating of multi-morphemic characters varies with word context. To avoid variation of transparency rating in multi-morphemic characters, mono-morphemic characters would be considered only.

Objectives

The purposes of the present study were 1) to investigate whether semantic transparency and homophonic neighborhood size play a role in the lexical processing of Chinese writing modality; if they do, 2) whether the two variables interact with each other and 3) the changes across grades which may reflect the developmental trend.

Method

Participants

A total of 160 children: 60 first graders, 50 third graders and 50 fifth graders were recruited for screening in a local primary school at the initial stage of the study. Each of them completed four screening tasks which including the Raven's Standard Progressive Matrices (SPM) (Raven, 1986), a standardized non-verbal intelligence test; the Standardized Graded Character Naming Test (GCNT) (Leung, Chang & Kwan, 2002), a reading screening test; a subtest of the Test of Visual-Perceptual Skills (non-motor) Revised (Gardner, 1996) and the Test of Visual-Motor Skills (Gardner, 1996), a visual-motor test, to avoid confounding factors of below-aged nonverbal cognitive ability, reading ability, visual perceptual and visual-motor coordination that might contaminate the experiment.

90 children, 30 from each grade, who obtained a score above -1.5 SD in SPM, the GCNT, the visual-perceptual as well as the visual-motor tests were selected as the participants of the present study. Age of participants and their performance in SPM, GCNT and tests of visual motor and perceptual were summarized in Table 1.

Table 1. Demographic variables and the performance in the screening task of the participants

Grade	*Male*	*Female*	*Age Range*	*Raven's (std score)*		*GCNT (z-score)*		*Visual Spatial (std score)*		*Visual Motor (std score)*	
				Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
One	16	14	6;02-7;00	100.63	11.95	0.020	1.11	125.30	13.16	117.27	13.92
Three	17	13	8;01-9;00	106.87	11.34	0.650	1.86	113.53	14.92	105.87	14.92
Five	12	18	10;03-11;00	104.10	11.89	0.15	0.81	115.37	14.31	107.93	14.59

Stimuli

The stimuli were chosen from the Hong Kong Corpus of Primary School Chinese (Leung & Lee, 2002). The factors of homophonic neighborhood size, semantic transparency and grades were manipulated whereas syllable frequency, character frequency, stroke complexity, word frequency and morphemic nature were controlled in preparing stimuli.

First of all, different characters occur in a particular grade were identified. All the characters with character frequency larger than zero were sorted according to their corresponding syllables in grade one, three and five from the Corpus (Leung & Lee, 2002). The character frequency was estimated by computing the total number of character occurrences. For homophone estimation across grades, characters with character frequency equals to zero in a particular grade were not counted as homophones of corresponding syllables in that grade because those characters have not been learnt by participants of that particular grade. For example, in Grade One, the syllable “faat3” corresponds to three characters “髮 (hair)”, “法 (method)” and “發 (rich)” which have frequencies higher than zero. The homophonic neighbourhood size of the syllable “faat3” is equal to three. The number of homophones correspond to each of the syllable, (homophone number) were counted. These characters were sorted according to their homophone number. Characters with extremely high and extremely low homophone numbers were taken as high and low homophonic neighbourhood sizes respectively. Stimuli used in current study were either high or low neighbourhood size as characters from the two extremities of homophonic neighbourhood sizes might prove significant homophony effect. After the sorting according to homophone number, characters in the two conditions of high homophonic neighbourhood size (H) and low homophonic neighbourhood sizes (L) of each grade were composed.

In current study, only compound characters with corresponding character frequency in the lowest 33.3% of the characters in the corresponding grade under H and L conditions were selected as candidate stimuli.

Based on the meaning represented by each candidate compound character chosen under the H and L conditions, each of them was rated on a six-point scale to mark the semantic transparencies (please refer to appendix A for the operational definition of each point with examples). The transparency ratings were agreed by 4th year undergraduate students in the Division of Speech and Hearing Sciences, The University of Hong Kong. Individual target characters rated as point 1 to 4 and point 6 were categorized under the conditions of transparent (T) and opaque (O) respectively. On completion of the semantic transparency rating, potential characters under the four conditions of each grade were created. They were high homophonic neighbourhood size transparent (HT), high homophonic neighbourhood size opaque (HO), low homophonic neighbourhood size transparent (LT) and low homophonic neighbourhood size frequency opaque (LO).

Individual candidate character in the HT, HO, LT and LO conditions of each grade was made to combine with another character to form disyllabic word excluding characters with multi-morphemic word combination from the corpus (Leung & Lee, 2002). Each candidate character was in the word-initial position of the mono-morphemic word. After the generation of mono-morphemic word, ten mono-morphemic words were selected as stimuli under the four conditions by controlling the character frequency, syllabic frequency, word frequency and number of stroke. Table 2 summarized the controlled parameters of the stimuli.

Table 2 Mean and SD of the controlled parameter of each category of stimuli

Grade	**Stimuli Condition**	**Syllable Frequency**		**Character Frequency**		**Word Frequency**		**Stroke Number**	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
P1	HT	13.35	6.28	14.00	7.20	5.10	4.12	10.90	2.10
	HO	13.69	6.63	15.00	8.43	5.10	4.51	11.00	3.23
	LT	14.40	3.48	14.40	3.48	4.20	1.68	11.50	4.20
	LO	14.9	6.85	14.9	6.86	4.50	4.09	10.50	1.30
P3	HT	16.52	6.44	14.60	3.32	2.20	1.28	11.70	2.64
	HO	17.43	3.79	15.80	3.00	1.90	0.54	13.20	2.84

	LT	15.60	2.48	15.60	2.48	1.80	0.96	10.80	2.56
	LO	14.80	2.96	14.80	2.96	2.00	0.80	12.00	3.40
P5	HT	22.15	5.46	21.70	7.24	2.70	1.98	16.30	3.36
	HO	22.50	5.86	21.78	7.31	2.40	1.08	12.60	2.40
	LT	22.10	7.52	22.10	7.52	2.20	1.48	11.90	2.50
	LO	22.00	7.44	22.00	7.44	2.50	1.60	14.10	1.74

Same procedures carried out in preparing stimuli of Grade one, Grade three and Grade five. As a result, three sets of 40 two-character words, were selected (see appendix B) for the present experiment. Examples of the stimuli are listed in Table 3. A pilot testing had been carried out to check whether there was any ceiling or floor effect.

Table3. Examples of Stimuli in all Four Categories across Grades

Grade	**Homophonic Neighbourhood size**	**Semantic Transparency**	
		Transparent (T)	**Opaque (O)**
One	**High**	枝頭	知道
	Low	肚皮	溫室
Three	**High**	菊花	宣佈
	Low	咳嗽	夢中
Five	**High**	蝸牛	蔚藍
	Low	踢球	笨重

Procedures

A writing-to-dictation task was administrated. A left-side-flipped dictation booklet with page number and a box printed on the right side while completely black on the left side was used to avoid priming effect of previous dictated characters. Each targeted character was to be written on a single page. . Participants' task was to write in respond to an auditory input. For example, the chief examiner would say: "溫室既溫(*wun1 sak1 ge3 wun1)*" where the target character was 溫 (*wun1*) and the participants would have to write the character "溫". The word initial character was written inside the box on the corresponding page of the booklet following the presentation of di-syllabic word verbally. Each participant has to do forty-eight characters, in which 40 were target characters and 8 fillers characters which are non-radical-compound characters.

Students of the same grade were divided into two groups and each group attended the test at a time. The order of presentation of the stimuli was counter balanced to cancel out the practice effect. Set A consisted of stimuli numbered 1 to 24 and set B comprised stimuli numbered 25-48 (see appendix B). Set A was presented prior to set B to students in Group One and vice versa to students in Group Two. There were four examiners responsible for the test. Three examiners monitored the students' behaviors to prevent them from copying others' work and writing in wrong pages as well as a chief examiner. After the booklet distribution, the chief examiner gave the task explanation by reading aloud a standard instruction (please see appendix C). During the test administration, the chief examiner presented the targeted word twice through a microphone with sound level of 71dB. The background noise was measured at a sound level of 50dB. A break of 5 minutes was demonstrated upon completion of 24 dictated characters.

Measurement

Dictation booklets were marked after the task administration. One mark was given to each correctly written character. No mark was given to any inaccurate written character. The total score of each of the four categories of each participant got was counted manually.

Data Analysis

A 3 x 2 x 2 three-way ANOVA with repeated measures was used to analyze the data collected. The grades of participants were set as between group factor with 3 levels (Grade One, Grade Three and Grade Five) while the homophonic frequency with 2 levels (high and low) and the semantic transparency with 2 levels (transparent and opaque) were set as the two within-group factors.

Result

The mean and standard deviation of the participants' performances in different homophonic frequency and semantic transparency conditions and overall performance were summarized in Table 3. The raw scores of each participant on the four conditions were entered for a 3-way ANOVA with repeated measures.

Table 3. Mean Percentage Scores of Participants' Overall Performance and in Different Homophonic Frequency and Semantic Transparency Conditions

Grade	**Overall percentage score (%)**	**Mean percentage score in different conditions (%)**			
	Mean (S.D.)			***Homophonic Neighbourhood Size***	
				High	*Low*
One	22.83 (10.23)	**Transparency**	*T*	31.67	38.00
			O	15.00	06.67
Three	29.00 (14.33)	**Transparency**	*T*	31.33	34.67
			O	30.00	20.00
Five	40.67 (14.61)	**Transparency**	*T*	43.67	46.33
			O	27.00	45.67

The main effects of semantic transparency and grade, 2-way interaction between homophonic neighbourhood size and grade as well as semantic transparency and grade and the 3-way interaction among the three factors were found to be significant.

Significant main effect of semantic transparency, $F(1, 87) = 148.38$, $p < .001$, was found. Pair-wise comparisons using Post hoc Tukey Honestly Significantly Difference (HSD) test demonstrated that participants performed significantly better in transparent characters than that of opaque characters ($p < .05$).

Main effect of grade was statistically different as well $F(2, 87) = 14.105$, $p < .001$ (Table 3). A Post hoc Tukey HSD test was administrated to identify the sources of significant difference. Grade Five students were found to be significantly better than the Grade One and Grade Three students, $p < .005$ whereas, the difference between the Grade One and Grade Three students was not significant.

The 2-way interaction effect between semantic transparency and grade was found to be significant, $F (2, 87) = 22.052$, $p < .001$. Results of Post hoc Tukey HSD test indicated that there was no significant difference among three grades on transparent characters. Regarding opaque characters, the performance of Grade One students was significantly worse than that of third and fifth graders, $p < .001$ (figure a), while the difference in the performance between Grade Three and Five students was not significant. It was suggested that Grade One students performed significantly worse than Grade Three and Grade Five students on opaque characters but not on transparent characters.

A statistically significant 2-way interaction effect was also found between homophonic frequency and grade, $F (2,87) = 8.6510$, $p < .001$. Results of Post hoc Tukey HSD test revealed that the performance of Grade Five students was significantly better on characters of low homophonic neighbourhood size than that of high homophonic neighbourhood size, $p < .001$ whereas the difference between the performances of high and low homophonic neighbourhood sizes were not significant in Grade One and Three students. The results indicated that homophony effect occurred in the Grade Five students only but not in first and fifth grades.

The 3-way interaction among all factors was also significant, $F (2, 87) = 16.359$, $p < .001$. Tukey HSD test was carried out to investigate the sources of significant interaction.

All pair-wise comparisons among different levels of homophonic neighbourhood size at the transparent condition were not significant across grades as shown in figure b. This suggested that homophony effect was absent as far as transparent character are concerned. Regarding opaque characters, Grade Five students performed significantly better in low homophonic neighbourhood size characters than high homophonic neighbourhood size characters, $p < .001$ but Grade One and Grade Three students did not performed significantly different in high and low neighbourhood sizes characters as shown in figure b. Such findings suggested that homophony effect occurs only when opaque character is processed in the Grade Five. However, the homophonic neigbhourhood size does not affect younger children's performances.

Pair-wise comparisons showed that Grade One students performed significantly better in transparent characters than opaque across the two homophonic neigbhourhood size levels, $p < .001$ as shown in figure b. This suggested that transparency effect occurred regardless of the differences of homophonic neigbhourhood size in Grade One.

For Grade Three, the pattern was similar to that of Grade One. Their performance was significantly better in transparent character than that of opaque character under low homophonic neighbourhood size condition $p < .001$. However, no such difference was found under high homophonic neighbourhood size. This result would be discussed later.

The performance of Grade Five students was significantly better in transparent characters than that of opaque characters under high homophonic neigbhourhood size condition but no difference was found under low homophonic neigbhourhood size condition.

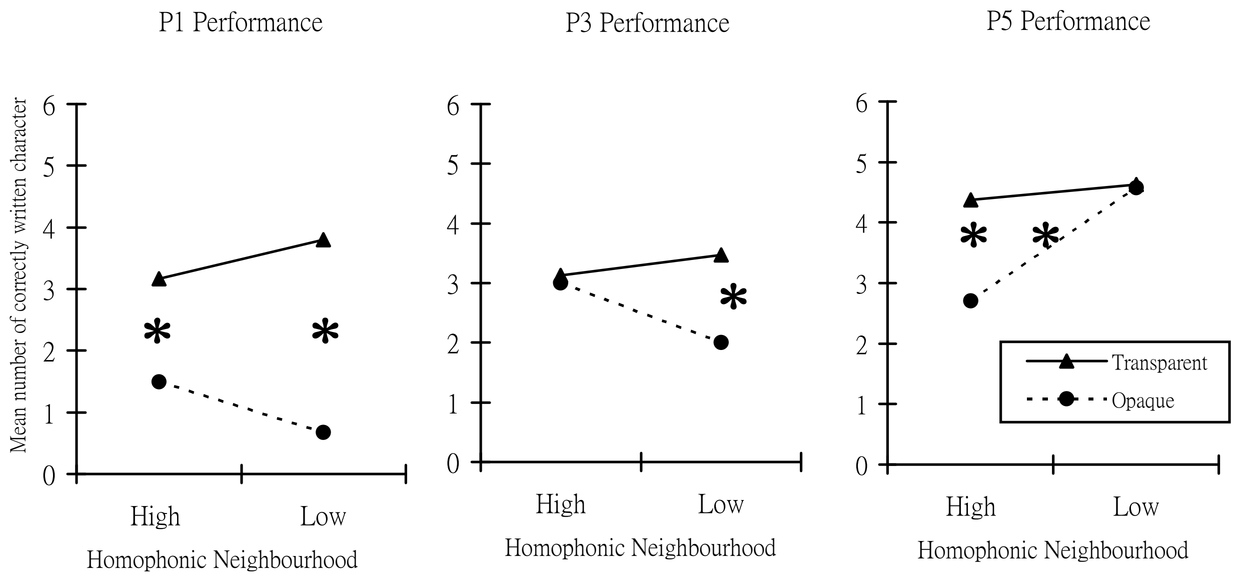

Figure b. Interaction of Grade, Semantic Transparency and Homophonic Frequency (lines with asterisk (*) indicate statistically significant difference, P<0.05)

<u>Discussion</u>

As predicted, the results were consistent with the findings of Shu & Anderson (1997), significant semantic transparency effect was found. Such semantic analogy in lexical processing extends to the writing-to-dictation paradigm. This semantic analogy is more prominent in a writing-to-dictation paradigm. Writing-to-dictation task involves a phonological input whereas orthographic form as output. The input constrained by phonology is ambiguous. Semantic representation is therefore assessed from phonological representation instead of assessing directly from phonological to orthographic representation. Semantic information conveyed by semantic radial is employed to get more cueing in assessing an exact semantic meaning of target characters which turn map to corresponding orthographic representation as output. Paradigms with orthographic input failed to force the individuals to assess the semantic representation as direct activation from orthographic to phonological representation is possible. Semantic analogy is not crucial under such paradigm which resulted in insignificantly transparency effect. The nature of paradigm determines the employment of sub-lexical semantic radical processing is evidenced by significant semantic transparency found in current study.

The results suggested that school-aged-children as young as Grade One has already referred semantic radicals of compound characters as contextual cues in lexical processing as skilled adult readers (Feldman & Siok, 1999; Ho et al., 1999). In transparent characters, the semantic representations activated by the semantic radicals are consistent with the semantic representations activated by the whole word as their semantic properties are similar. This has enhanced children's ability to retrieve the corresponding character of the phonologically presented word and map onto its accurate orthographic representation. In opaque words, the semantic representations of whole words may be inhibited due to the disconnection of semantic features between the semantic radicals and the whole words. Mapping of meaning to orthographic representations of characters in opaque words is diminished and resulted in worse performance.

Main effect of grade was obtained in the current study. Since character frequency and syllabic frequency were controlled according to the corresponding grade level; different sets of stimuli were used for different graders in the present study, an explanation of lacking control of stimuli frequencies was excluded. A more feasible explanation is that higher graders have mastered a better writing skill as evidenced by the significant 2-way interaction between homophonic neigbhourhood size and grade. Grade Five students performed significantly better in characters of low homophonic neighbourhood size than Grade One and Grade Three students graders suggested that writing ability of student improved across grade. Up to Grade Five, their skills are much mature than that of Grade Three and Grade One. Better writing skill in fifth graders leads to their better performance in current study.

A significant interaction effect between homophonic neighbourhood size and semantic transparency was identified in Grade Five students. Consistent with the prediction, the results suggested that transparency effect showed in characters of large homophonic neighborhoods size in Grade Five students. In characters with large homophonic neighborhood size, phonological unit of the spoken syllable activates all orthographic forms of its homophones and may result in competition. This direct activation of phonology to orthography is unreliable as the orthographic competition induced provides no information to retrieve the exact orthography of the target character. Based on the same token, when a direct assess of phonology to semantics is carried out, the fact that semantic representations of all homophones of the character are activated would lead to ambiguity. Mapping of orthographic form to semantic representation of the target character presented auditorily is negatively affected because of the competition induced by the activation of semantic representations. A semantic competition is induced between the target character and its homophones. The sub-character processing of semantic radical has to be employed to reduce the ambiguity because of the activation of homophones. Under transparent condition, stronger activation by the semantic radicals to the semantic representation of whole word facilitates the exact retrieval of the target characters. Consequently better performance resulted. Such results supported the argument of Zhou & Marslen-Wilson (1999) that an interactive access of orthography and phonology to semantics in Chinese script is evidenced. For opaque condition, activation of semantic radicals affects the semantic representation negatively. Irrelevant information of semantic radical intensifies the inaccurate retrieval.

In characters with small homophonic neighborhood size, the spoken syllable resembles an orthographic form as well as a semantic representation. Without competition of representation among homophones, it facilitates the retrieval of exact and accurate target character. Inferring sub-character semantic radical processing is not curial in such condition.

In the present study, a significant interaction between homophony and grade was contributed by the occurrence of homophony effect in fifth graders but not in first and third graders. It might reflect that homophony effect emerged in Grade Five. Consistent with prediction, homophony effect becomes prominent as children promote to higher grade. Such results can be accounted for by the expansion of homophonic neighborhood size across grades. Amount of characters acquired by children increases as children are promoted to higher grade. The size of orthographic lexicon and semantic lexicon increases but the spoken syllables in phonological lexicon is fixed due to limited syllables in Cantonese. Thus, more orthographic units map on to the limited phonological units. In other words, the homophonic neighborhoods size expands automatically as children move to higher grades. This is reflected by the fact that the differences of homophone number between characters in large and small homophonic neighborhood sizes are less prominent in Grade One and Grade Three students as summarized in table 4. This might explain why homophony effect occurred in Grade Five students only. Such findings further suggested that extensive homophones in Chinese become a influential factor to school-aged-children's writing-to-dictation as they grow older.

Table 4. Mean Number of Homophony of Target Characters under High and Low Homophonic Neigbhourhood Size Condition

Grade	**Mean Number of Homophony**	
	Homophonic Neighbourhood Size	
	Low	*High*
One	1.0	4.1
Three	1.0	4.7
Five	1.0	6.0

By comparing the interaction effect of homophonic neighbourhood size and semantic transparency in first graders and fifth graders, (refer to figure b), the development of sub-character processing of semantic radical in writing modality across grades is implicated. For Grade One students, transparency effect occurred in both high and low homophonic neighbourhood size conditions. It suggested that the decomposition of semantic radicals from whole compound character to cue for semantic representation is used by Grade One students in dictation regardless the reliability of mapping from phonological unit to semantics and orthographic unit at whole character level as the linking between them is still not strong. More routes should be employed in lexical processing. As children grow older and gain more exposures to compound characters in school and other environment, direct activation of phonology to both orthography and semantics are built. The use of sub-character semantic radicals to provide semantic information is only employed when mappings from phonology to semantics and orthography are unreliable or when the character frequency is exceptionally low. The dominant role of sub-lexical semantic radical processing diminished to avoid being overused. It is evidenced by the findings that transparency effect was shown under high homophonic neighbourhood size condition in Grade Five.

Contrary to expectation, in high homophonic neighbourhood size condition, transparency effect was not found for Grade Three students. Since the syllable to homophonic frequency ratio, character frequency, word frequency, morphemic characteristic and stroke complexity were controlled they could not contribute to the present pattern. A possible explanation for the insignificant transparency effect in large homophonic neighborhood size is the lack of control on the consistency of semantic transparency of target characters and their homophonic counterparts in high homophonic neighbourhood size groups. Investigation on the consistency of transparency rating on the homophonic family of each target character in each grade was carried out (refer to table 5). The findings revealed that the mean transparency ratings of each target characters and its homophonic neighborhoods in both H T and H O conditions were comparable across grades. This explanation cannot be correct.

Table 5. Mean Transparency Rating of Target Character in High homophonic Neighbourhood size Transparent and Opaque Conditions in Three Grades

Grade	**Mean transparency rating**	
	High Homophonic neighbourhood size	
	Transparent	*Opaque*
One	3.934	5.340
Three	3.184	4.925
Five	3.830	4.861

Alternative explanation is that the phonetic regularity of the target characters might have contributed to the current finding. Phonetic regular characters were not excluded in preparing stimuli. According to the results of Kwok (2003), it indicated that significant regularity effect was occurred in children of Grade Three and Five but the effect did not occur at Grade One. Thus, it appears that student of Grade Three and Grade Five acquired the ability to decompose the phonetic radical to denote the pronunciation of whole word. The predominate activation of phonetic radicals or completion in the activation of both semantic and phonetic radical influenced both students of Grade Three and Grade Five in doing the writing-to-dictation of characters which are both semantic transparent and phonetic regular. In both phonetic regular and semantic transparent characters, two possible processes are operating. One is that phonetic radicals which pronounce as the same as the whole characters are activated and map onto the corresponding orthographic representations of the phonetic radicals as output regardless the employment of semantic radicals to cue the meaning of the whole word. Another one is that the activation of phonetic radicals competes with the activation of semantic radicals to map onto their corresponding orthographic representations. As a result, effects of each other are cancelled out. Within these two routes of processing, children write worse in characters with both phonetic regular and semantic transparent characters.

Nevertheless, the fact that no transparency effect was detected under the high homophonic neighbourhood size condition in third graders might be contributed by the inclusion of more transparent and regular characters in the high homophonic neighbourhood size condition of Grade Three. An analysis on the phonetic regularity of the transparent characters in stimulus character was carried out for Grade Three and Grade Five. The percentage of both regular and transparent characters is relatively higher in the high homophonic frequency condition of Grade Three (refer to Table 6). As a result, the transparency effect might be inhibited.

Table 6. Percentage of both Transparent and Regular Characters under High and Low Homophonic Neighbourhood Size Conditions in Grade Three and Five

Grade	**Percentage of both transparent and regular characters (%)**	
	Homophonic frequency	
	High	*Low*
Three	**40**	10
Five	20	0

Conclusion

In summary, the use of sub-character processing of semantic radicals in semantic phonetic compound characters is demonstrated in a writing-to-dictation task of low-frequency characters for children as young as Grade One. Number of homophones of characters is evidenced to affect the performance of writing-to-dictation as they grow older. Specially, the higher the homophonic neighbourhood sizes the poorer the performance when the character is semantically opaque.

The current study provides an insight on the Chinese writing system of children that the decomposition of semantic radical to cue the meaning of the whole character is more prominent in writing when comparing to paradigm such as character recognition, semantic categorization and priming tasks. Another implication is that the effects of homophonic neigbhourhood size in Chinese affect school-aged children's writing-to-dictation as they promote across grade.

Further investigation in the interaction between activation of phonetic and semantic radicals could be carried out by employing the writing-to-dictation paradigm which require a more prominent use of semantic analogy in the process.

References

Chung, F. (2004). Semantic categorization of Chinese character: semantic radical plays an important role? *Unpublished Bachelor Dissertation*, The University of Hong Kong.

Chen, M. J. (1996). An overview of the characteristics of the Chinese writing system. *Asia Pacific Journal of Speech*, *Language and Hearing*, *1*, 43-54.

Chen, X., Anderson, R. C., Li, H., & Shu, H. (in press). Developmental Stages in Learning to Read Chinese.

Feldman, L. B., & Siok, W. W. T. (1999). Semantic radicals contribute to the visual identification of Chinese Characters. *Journal of Memory and Language, 40*, 559-576

Ho, C. S. –H., Wong, W.-L., & Chan, W. –S. (1999). The use of orthographic analogies in learning to read Chinese. *Journal of Child Psychology*, *40*, 393-403.

Gardner, M.F. (1996). *Test of Visual-Perceptual Skills (non-motor) Revised.* Psychological and Educational Publications, Inc.

Gardner, M.F. (1996). *Test of Visual-motor Skills Revised.* Psychological and Educational Publications, Inc.

Kwan, S. M. (2003). Is the understanding of character meaning affected by semantic transparency? A study of Hong Kong school-aged children. *Unpublished Dissertations for the Bachelor of Science (Sp. & Hear. Sc.).* Hong Kong : University of Hong Kong

Lam, P. M. M. (2003). Spelling without sound and meaning. *Unpublished Dissertations for the Bachelor of Science (Sp. & Hear. Sc.).* Hong Kong : University of Hong Kong

Lee, C-Y., Tsai, J-L., Su, E. C-I., Tzeng, O. J. L., & Hung, D. L. (2005). Consistency, regularity, and frequency effects in naming Chinese characters. *Language and Linguistics*, *6*, 75-107

Leung, M. T., Chang-Lai, A., & Kwan, E. (2006). *The standardized graded character naming test for school-age children in Hong Kon*g. Paper to be presented at the annual general meeting of the Hong Kong Psychological Society, Hong Kong.

Leung M.T. & Lee, A. (2002). *The Hong Kong Corpus of Primary School Chinese*. Paper presented at the 9th Meeting of the International Clinical Phonetics and Linguistics Association. Hong Kong.

Li, P., & Yip, M. C. (1998). Context effects and the processing of spoken homophones. *Reading and Writing. 10 (3-5)*, 223-243

Perfetti, C. A., & Tan, L. H. (1997). Visual Chinese character recognition: Does phonological information medicated access to meaning. *Journal of Memory and Language, 31*, 41-57

Raven, J.C. (1986). *Hong Kong Supplement to Guide to the Standard Progressive Matrices*. H.K.: Education Department, H.K.

Shu, H. & Anderson, R.C. (1997). Role of radical awareness in the character and word acquisition of Chinese children. *Reading Research Quarterly, 32(1),* 78-89

Shu, H., Anderson, R.C., Wu, N., & Xuan, Y. (2003). Properties of school Chinese. *Child Development, 74(1),* 27-47.

Shu, H. & Cheung, T. C. (2001). Ting Se Jam Mou Haa Ji Tong Hon Zi Soet Zak Dim Kap Jing Hoen Jan Sou Dik Jin Gau. *Sum Lei Faat Zin Ju Gaau Juk (1*), 1-5. (In Chinese)

Tan, L. H., & Perfetti, C. A. (1997) Visual Chinese Character recognition: Does phonological information mediate access to meaning? *Journal of Memory and Language*, *37*, 41-57

Taft, M., Zhu, X., & Peng, D. (1999). Positional specificity of radicals in Chinese character recognition. *Journal of Memory and Language, 40*, 498-519.

Zhang, S., Perfetti, C. A., & Yang, H. (1999). Whole word, frequency-general phonology in semantic processing of Chinese Characters. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*, 858-875

Zhou, X., & Marslen-Wilson, W. (1999). Phonology, orthography, and semantic activation in reading Chinese. *Journal of Memory and Language*, *41*, 579-606.

Appendix A

Transparency ratings	Definition	Example	
Point		Target character	Semantic radical
One	Target character shares the same meaning as the semantic radical	“觀” (see)	“見” (see)
Two	The meaning of target character falls into the category that the semantic radical presents	“姨” (auntie)	“女” (female)
Three	The meaning of target character is directly related to that of the semantic radical	“捉到” (catch)	“手” (hand)
Four	The meaning of target character is loosely related to that of semantic radical	“浴” (bath)	“氵” (water)
Five	The meaning of target character is indirectly related to that of semantic radical	“鏡” (mirror)	“金” (metal)
Six	The meaning of target character is unrelated to that of semantic radical	“溫” (warm)	“氵” (water)

Appendix B

Grade One

HL	HO	LT	LO
鬍子	陵墓	諾言	罵人
瘦弱	欺壓	掩蓋	崇尚
帳篷	蔚藍	怨言	笨重
擊鼓	孤寂	挖掘	骯髒
撒下	複雜	磚塊	夢境
摘取	凋謝	盼望	稍後
蝸牛	倘若	咳嗽	稿紙
擾亂	敲打	踢球	鍛煉
誇耀	樸素	嘔吐	遮擋
纜車	糟糕	帽子	蘊藏

Grade Three

HL	HO	LT	LO
褲子	敵國	搶先	遮住
梨子	籠裏	愁悶	夢中
梅樹	罪名	挑選	勸告
叮嚀	碧綠	咳嗽	宏偉
菊花	孤單	拖把	狂奔
箭尾	宣佈	飽滿	鍛鍊

浴室	欺負	燦爛	奪標
缸裏	優秀	拼命	佔領
基本	釣魚	茂盛	陷阱
職務	隔壁	披上	殺死

Grade Five

HL	**HO**	**LT**	**LO**
鬍子	陵墓	諾言	罵人
瘦弱	欺壓	掩蓋	崇尚
帳篷	蔚藍	怨言	笨重
擊鼓	孤寂	挖掘	骯髒
撤下	複雜	磚塊	夢境
摘取	凋謝	盼望	稍後
蝸牛	倘若	咳嗽	稿紙
擾亂	敲打	踢球	鍛煉
誇耀	樸素	嘔吐	遮擋
纜車	糟糕	帽子	蘊藏

Appendix C

Instructions:

名位小朋友你地而家檯面上面有一本默書簿

而家你地可以係默書簿上面填上姓名、班別、性別、出生日期同埋今日嘅測驗日期

甘而家可以打開第一頁, 你地會見到兩版黑色, 請你地再揭一版

你會係右手邊見到一個方格, 而上面有 p.48 呢個數字

一間我會講出要默的字 例如: 水果個水字, 咁你地要將個水字默係埋個方格入面

每默完一個字就揭去之後個頁，如此類推

揭左去後面個頁就唔好再去返之前個頁睇

明唔明白

Appendix D

Grade One

Stimuli (SET A)

48	枝頭	24	愉快
47	郊區	23	佈滿
46	觀看	22	跌倒
45	深綠	21	透明
44	姨母	20	棉花
43	*小孩*	*19*	*月亮*
42	傳播	18	知道
41	肚皮	17	咬碎
40	秩序	16	特別
39	捉到	15	稻米
38	故事	14	員工
37	*女人*	*13*	*金錢*
36	熱鬧	12	拉緊
35	破壞	11	注重
34	蝴蝶	10	游泳
33	適合	9	留意
32	味道	8	談笑

Stimuli (SET B)

48	愉快	24	枝頭
47	佈滿	23	郊區
46	跌倒	22	觀看
45	透明	21	深綠
44	棉花	20	姨母
43	*月亮*	19	*小孩*
42	知道	18	傳播
41	咬碎	17	肚皮
40	特別	16	秩序
39	稻米	15	捉到
38	員工	14	故事
37	*金錢*	13	*女人*
36	拉緊	12	熱鬧
35	注重	11	破壞
34	游泳	10	蝴蝶
33	留意	9	適合
32	談笑	8	味道

31	*天堂*	*7*	*魚兒*
30	溫室	6	忽然
29	桃花	5	伯父
28	隨便	4	脫落
27	背後	3	河裏
26	試驗	2	糖果
25	*水果*	*1*	*男人*

31	*魚兒*	7	*天堂*
30	忽然	6	溫室
29	伯父	5	桃花
28	脫落	4	隨便
27	河裏	3	背後
26	糖果	2	試驗
25	*男人*	1	*水果*

Grade Three

Stimuli (SET A)

48	褲子	24	叮嚀
47	敵國	23	碧綠
46	搶先	22	咳嗽
45	遮住	21	宏偉
44	職務	20	浴室
43	*人心*	*19*	*山火*
42	隔壁	18	欺負
41	披上	17	燦爛
40	殺死	16	奪標
39	梨子	15	菊花
38	籠裏	14	孤單
37	*你們*	*13*	*水果*
36	愁悶	12	拖把
35	夢中	11	狂奔
34	基本	10	箭尾
33	釣魚	9	宣佈
32	茂盛	8	飽滿
31	*我們*	*7*	*鳥兒*

Stimuli (SET B)

48	叮嚀	24	褲子
47	碧綠	23	敵國
46	咳嗽	22	搶先
45	宏偉	21	遮住
44	浴室	20	職務
43	*山火*	19	*人心*
42	欺負	18	隔壁
41	燦爛	17	披上
40	奪標	16	殺死
39	菊花	15	梨子
38	孤單	14	籠裏
37	*水果*	13	*你們*
36	拖把	12	愁悶
35	狂奔	11	夢中
34	箭尾	10	基本
33	宣佈	9	釣魚
32	飽滿	8	茂盛
31	*鳥兒*	7	*我們*

30	陷阱	6	鍛鍊
29	梅樹	5	缸裏
28	罪名	4	優秀
27	挑選	3	拼命
26	勸告	2	佔領
25	*田地*	*1*	*大小*

30	鍛鍊	6	陷阱
29	缸裏	5	梅樹
28	優秀	4	罪名
27	拼命	3	挑選
26	佔領	2	勸告
25	*大小*	1	*田地*

Grade Five

Stimuli (SET A)

48	帽子	24	擾亂
47	蘊藏	23	敲打
46	纜車	22	磚塊
45	糟糕	21	鍛煉
44	誇耀	20	擊鼓
43	*火災*	*19*	*田園*
42	樸素	18	孤寂
41	嘔吐	17	挖掘
40	遮擋	16	骯髒
39	鬍子	15	蝸牛
38	陵墓	14	倘若
37	*手腳*	*13*	*馬仔*
36	諾言	12	咳嗽
35	罵人	11	稿紙
34	瘦弱	10	撤下
33	欺壓	9	複雜
32	掩蓋	8	踢球
31	*耳朵*	*7*	*音樂*

Stimuli (SET B)

48	擾亂	24	帽子
47	敲打	23	蘊藏
46	磚塊	22	纜車
45	鍛煉	21	糟糕
44	擊鼓	20	誇耀
43	*田園*	19	*火災*
42	孤寂	18	樸素
41	挖掘	17	嘔吐
40	骯髒	16	遮擋
39	蝸牛	15	鬍子
38	倘若	14	陵墓
37	*馬仔*	13	*手腳*
36	咳嗽	12	諾言
35	稿紙	11	罵人
34	撤下	10	瘦弱
33	複雜	9	欺壓
32	踢球	8	掩蓋
31	*音樂*	7	*耳朵*

30	崇尚	6	夢境
29	帳篷	5	摘取
28	蔚藍	4	凋謝
27	怨言	3	盼望
26	笨重	2	稍後
25	*日月*	*1*	*早晨*

30	夢境	6	崇尚
29	摘取	5	帳篷
28	凋謝	4	蔚藍
27	盼望	3	怨言
26	稍後	2	笨重
25	*早晨*	1	*日月*

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